

Claims

1. An image display device comprising:
 - an image display element;
 - a transmission type diffraction optical element for diffracting exit lights from the image display element; and
 - a reflection type optical element having a positive optical power for reflecting the diffracted lights from the transmission type diffraction optical element,

wherein when the reflected lights reflected by the reflection type optical element having the positive optical power are incident again on the transmission type diffraction optical element, the transmission type diffraction optical element diffracts the reflected lights with a diffraction efficiency lower than a diffraction efficiency for the exit lights from the image display element.
2. The image display device according to claim 1, wherein the transmission type diffraction optical element receives chief rays of the exit lights from the image display element at an angle of incidence of 5° or more with respect to the normal of a light receiving surface.
3. The image display device according to claim 1, wherein the transmission type diffraction optical element is a volume type hologram optical element.
4. The image display device according to claim 1, wherein the transmission type diffraction optical element is composed of diffraction gratings disposed with

uneven spaces.

5. The image display element according to claim 1, wherein the transmission type diffraction optical element is a polarization selective hologram optical element.
6. The image display device according to claim 5, wherein the polarization selective hologram optical element is a holographic polymer dispersed liquid crystal optical element.
7. The image display device according to claim 6, wherein the holographic polymer dispersed liquid crystal optical element has a P polarization diffraction efficiency higher than an S polarization diffraction efficiency.
8. The image display device according to claim 1, wherein the reflection type optical element having the positive optical power is a reflection type volume hologram optical element.
9. The image display device according to claim 1, wherein the reflection type optical element is a concave reflecting mirror and the reflection surface of the reflecting mirror is formed to have one plane of symmetry and no rotation symmetry axis inside and outside the plane.
10. The image display device according to claim 1, wherein the reflection type optical element having the positive optical power is made of a semi-transmission material for transmitting at least a part of lights from a rear surface side to a front surface side as a transmission type diffraction optical

element side.

11. The image display device according to claim 1, wherein a quarter-wave plate is provided in an optical path between the transmission type diffraction optical element and the reflection type optical element having the positive optical power.

12. The image display device according to claim 1, wherein an optical medium having a refractive index larger than 1 is arranged in the optical path between the image display element and the transmission type diffraction optical element.

13. The image display device according to claim 12, wherein the exit lights from the image display element are internally reflected at least one or more times in the optical medium, and then, incident on the transmission type diffraction optical element.

14. The image display device according to claim 1, wherein the transmission type diffraction optical element optically comes into contact with the reflection type optical element.

15. The image display device according to claim 10, wherein the transmission type diffraction optical element is a polarization selective hologram optical element and a polarizing plate is disposed in the rear surface side of a plane of the reflection type optical element on which the diffracted lights are incident.

16. The image display device according to claim 15, wherein the polarizing

plate is arranged to mainly transmit the lights with such a polarizing orientation as to make minimum the diffraction efficiency of the transmission type diffraction optical element.

17. The image display device according to claim 15, wherein the polarizing plate can rotate on an axis substantially vertical to a light receiving surface.

18. The image display device according to claim 10, wherein a first polarizing plate, the quarter-wave plate and a second polarizing plate are sequentially arranged in the rear surface side of the plane of the reflection type optical element on which the diffracted lights are incident.

19. The image display device according to claim 18, wherein at least one of the quarter-wave plate and the polarizing plates can respectively rotate on axes substantially vertical to their light receiving surfaces.

20. An image display device comprising:

an image display element;

a transmission type diffraction optical element for receiving exit lights from the image display element; and

a reflection type optical element having a positive optical power for reflecting the exit lights from the image display element which pass through the transmission type diffraction optical element without being diffracted in the transmission type diffraction optical element,

wherein when the reflected lights reflected by the reflection type optical

element having the positive optical power are incident again on the transmission type diffraction optical element, the transmission type diffraction optical element diffracts the reflected lights with a diffraction efficiency higher than a diffraction efficiency for the exit lights from the image display element.

21. The image display device according to claim 20, wherein the transmission type diffraction optical element receives chief rays of the exit lights from the image display element at an angle of incidence of 5° or more with respect to the normal of a light receiving surface.

22. The image display device according to claim 20, wherein the transmission type diffraction optical element is a volume type hologram optical element.

23. The image display device according to claim 20, wherein the transmission type diffraction optical element is composed of diffraction gratings disposed with uneven spaces.

24. The image display element according to claim 20, wherein the transmission type diffraction optical element is a polarization selective hologram optical element.

25. The image display device according to claim 24, wherein the polarization selective hologram optical element is a holographic polymer dispersed liquid crystal optical element.

26. The image display device according to claim 25, wherein the holographic polymer dispersed liquid crystal optical element has a P polarization diffraction

efficiency higher than an S polarization diffraction efficiency.

27. The image display device according to claim 20, wherein the reflection type optical element having the positive optical power is a reflection type volume hologram optical element.

28. The image display device according to claim 20, wherein the reflection type optical element having the positive optical power is a concave reflecting mirror and the reflection surface of the reflecting mirror is formed to have one plane of symmetry and no rotation symmetry axis inside and outside the plane.

29. The image display device according to claim 20, wherein the reflection type optical element having the positive optical power is made of a semi-transmission material for transmitting at least a part of lights from a rear surface side to a front surface side as a transmission type diffraction optical element side.

30. The image display device according to claim 20, wherein a quarter-wave plate is provided in an optical path between the transmission type diffraction optical element and the reflection type optical element having the positive optical power.

31. The image display device according to claim 20, wherein an optical medium having a refractive index larger than 1 is arranged in the optical path between the image display element and the transmission type diffraction optical element.

32. The image display device according to claim 31, wherein the exit lights from the image display element are internally reflected at least one or more times in the optical medium, and then, incident on the transmission type diffraction optical element.

33. The image display device according to claim 20, wherein the transmission type diffraction optical element optically comes into contact with the reflection type optical element.

34. The image display device according to claim 29, wherein the transmission type diffraction optical element is a polarization selective hologram optical element and a polarizing plate is disposed in the rear surface side of a plane of the reflection optical element on which the diffracted lights are incident.

35. The image display device according to claim 34, wherein the polarizing plate is arranged to mainly transmit the lights with such a polarizing orientation as to make minimum the diffraction efficiency of the transmission type diffraction optical element.

36. The image display device according to claim 34, wherein the polarizing plate can rotate on an axis substantially vertical to a light receiving surface.

37. The image display device according to claim 29, wherein a first polarizing plate, the quarter-wave plate and a second polarizing plate are sequentially arranged in the rear surface side of the plane of the reflection type optical element on which the diffracted lights are incident.

38. The image display device according to claim 37, wherein at least one of the quarter-wave plate and the polarizing plates can respectively rotate on axes substantially vertical to their light receiving surfaces.